COMBINATIONS OF EOP MEASUREMENTS: COMB94 & POLE94

EOP(JPL) 95 C 02
EOP(JPL) 95 C 03

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A Kalman filter has been used to combine independent measurements of the Earth's orientation taken by optical astrometry and the space-geodetic techniques of LLR, SLR, VLBI, and GPS. Prior to incorporation of the optical astrometric measurements, the space-geodetic measurements were first combined together, resulting in the combined EOP series EOP (JPL) 95 C 01 (a.k.a. SPACE94), the description of which can be found elsewhere in this volume. The incorporation of the optical astrometric measurements was then done in two stages: (1) the BIH optical astrometric series (Li, BIH Annual Report for 1984, pp. D31-D63) was first combined with SPACE94 to form COMB94, and (2) the International Latitude Service (ILS) optical astrometric series (Yumi and Yokoyama, Results of the ILS in a Homogeneous System, 1980) was combined with COMB94 to form POLE94.

Prior to forming COMB94, the BIH astrometric series was first corrected to have the same bias and rate as SPACE94, the stated measurement uncertainties of the BIH series were adjusted by applying a constant multiplicative scale factor that made the BIH residual, when difference with SPACE94, have a reduced chi-square of one; and those BIH data points whose residual values were greater than three times their adjusted uncertainties were deleted. In addition, in order to correct for systematic, seasonally varying effects in optical astrometric measurements, the annual term of the BIH series was adjusted to be in agreement with the annual term exhibited by SPACE94. The corrections thus determined and applied to the BIH series prior to its combination with SPACE94 are shown in Tables 1 and 2, with the l-sigma formal uncertainties in determining these bias, rate, and annual term corrections being shown in parentheses.

The result of combining the corrected BIH optical astrometric EOP measurements with SPACE94 is designated EOP(JPL) 95 C 02 (a.k.a. COMB94), spans January 20, 1962 to January 27, 1995 at 5-day intervals, and consists of values of PMX, PMY, UT1-UTC, their l-sigma formal uncertainties, and correlations.

The ILS optical astrometric series was then combined with COMB94 to form POLE94 after first: (1) correcting the ILS series to have the same bias, rate, and annual term as COMB94, (2) applying a constant multiplicative scale factor to the stated measurement uncertainties of the ILS series so that its residual, when difference with COMB94, had a reduced chi-square of one, and (3) deleting those data points whose residual values were greater than three times their adjusted uncertainties (see Tables 1 and 2 for the values of the corrections applied to the ILS series). The result of combining the corrected ILS optical astrometric EOP measurements with COMB94 is designated EOP(JPL) 95 C 03 (a.k.a. POLE94), spans January 20, 1900 to January 21, 1995 at 30.4375-day intervals, and consists of values of PMX and PMY, their l-sigma formal uncertainties, and correlations.

TABLE 1. ADJUSTMENTS TO BIAS, RATE, AND UNCERTAINTY

DATA SET NAME	BIAS (mas)			RATE (mas/yr)			UNCERTAINTY SCALE FACTOR		
BIH	PMX	PMY	UT1	PMX	PMY	UT1	PMX	PMY	UT1
	7.993	6.035	35.094	1.030	0.414	5.251	1.830	1.601	1.865
	(4.280)	(1.893	(2.937	(0.483)	(0.180)	0.316)			
I LS	PMX	PMY	UT1	PMX	PMY	UT1	PMX	PMY	UT1
	-49.540	7.389	—-	0.053	-0.876	-	1.999	1.599	---
	(2.177)	(1.747)		(0.444)	(0.356)				

Reference date for rate adjustment. of BIH series is 1988.0
Reference date for rate adjustment. of ILS series is 1970.0

TABLE 2. ADJUSTMENT TO ANNUAL COMPONENT

DATA SET NAME	COEFFICIENT OF SINE TERM (mas)			COEFFICIENT OF COSINE TERM (mas)		
BIH	PMX	PMY	UT 1	PMX	PMY	UT1
	-5.627	-6.749	5.322	-2.799	9.824	-0.922
	(1.017)	(0.621	(0.781.	(1.069)	(0.683)	(0.832)
ILS	PMX	PMY	UT 1	PMX	PMY	UT1
	-0.406	8.055	---	10.036	-10.922	---
	(3.059)	(2.453)		(3.063)	(2.457)	

Reference date for adjustment of BIH series is 1988.0
Reference date for adjustment of ILS series is 1970.0

ACKNOWLEDGMENTS . The work described in this paper was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

ATTACHMENT 1

Technical description of solution JPL, 95 C 02

1 - Technique(s) : Combined

2 - Analysis Center: JPL

3 - Software used: Kalman Earth Orientation Filter (KEOF)

4 - Data span: Jan 1962 - Jan 1995 at 5-day intervals

5 - Celestial Reference Frame: Not Applicable

a - Nature:

b - Definition of the orientation:

6 – Terrestrial Reference Frame: Not Applicable

a - Relativity scale:

b - Velocity of light:

c – Geogravitational constant:

d - Permanent tidal correction:

e - Definition of origin:

f - Definition of orientation:

g - Reference epoch:

h - Tectonic plate model:

i - Constraint for time evolution:

7 - Earth orientation: EOP(JPL) 95 C 02 (a.k.a. COMB94)

a - A priori nutation model: Not Applicable

b - Short-period tidal variations in x, y, UT1:

When necessary, the diurnal and semi-diurnal tidal variations have been removed from the individual EOP series prior to their combination into EOP(JPL) 95 C 02. The diurnal and semi-diurnal tidal terms have not been added back to the values reported in EOP(JPL) 95 C 02.

c – Definition of the reference frame:

EOP(JPL) 95 C 02 has been aligned with EOP(JPL) 95 C 01 which was in turn aligned with the IERS combined Earth orientation series EOP(IERS) 90 C 04 during 1984-1994. EOP(JPL) 95 C 02 is therefore given within that reference frame defined by EOP(IERS) 90 C 04.

8 - Estimated Parameters:

a – Celestial Frame:

b – Terrestrial Frame:

c - Earth Orientation: PMX, PMY, UT1-UTC

d - Others:

ATTACHMENT' 2

Technical description of solution JPL 95 C 03

1 -- Technique(s) : Combined

2 - Analysis Center: JPL

3 - Software used: Kalman Earth Orientation Filter (KEOF)

4 - Data span: Jan 1900 - Jan 1995 at 30.4375-day intervals

5 - Celestial Reference Frame: Not Applicable

a - Nature:

b - Definition of the orientation:

6 - Terrestrial Reference Frame: Not Applicable

a - Relativity scale:

b - Velocity of light:

c - Geogravitational constant:

d - Permanent tidal correction:

e – Definition of origin:

f - Definition of orientation:

g - Reference epoch:

h - Tectonic plate model.:

i - Constraint for time evolution:

7 - Earth orientation: EOP(JPL) 95 C 03 (a.k.a. POLE94)

a - A priori nutation model: Not Applicable

b - Short-period tidal variations in x, y, UT1:

When necessary, the diurnal and semi-diurnal tidal variations have been removed from the individual EOP series prior to their combination into EOP(JPL) 95 C 03. The diurnal and semi-diurnal tidal terms have not been added back to the values reported in EOP(JPL) 95 C 03.

c - Definition of the reference frame:

EOP(JPL) 95 C 03 has been indirectly aligned with the IERS combined Earth orientation series EOP(IERS) 90 C 04 during 1984-1994. EOP(JPL) 95 C 03 is therefore given within that reference frame defined by EOP(IERS) 90 C 04.

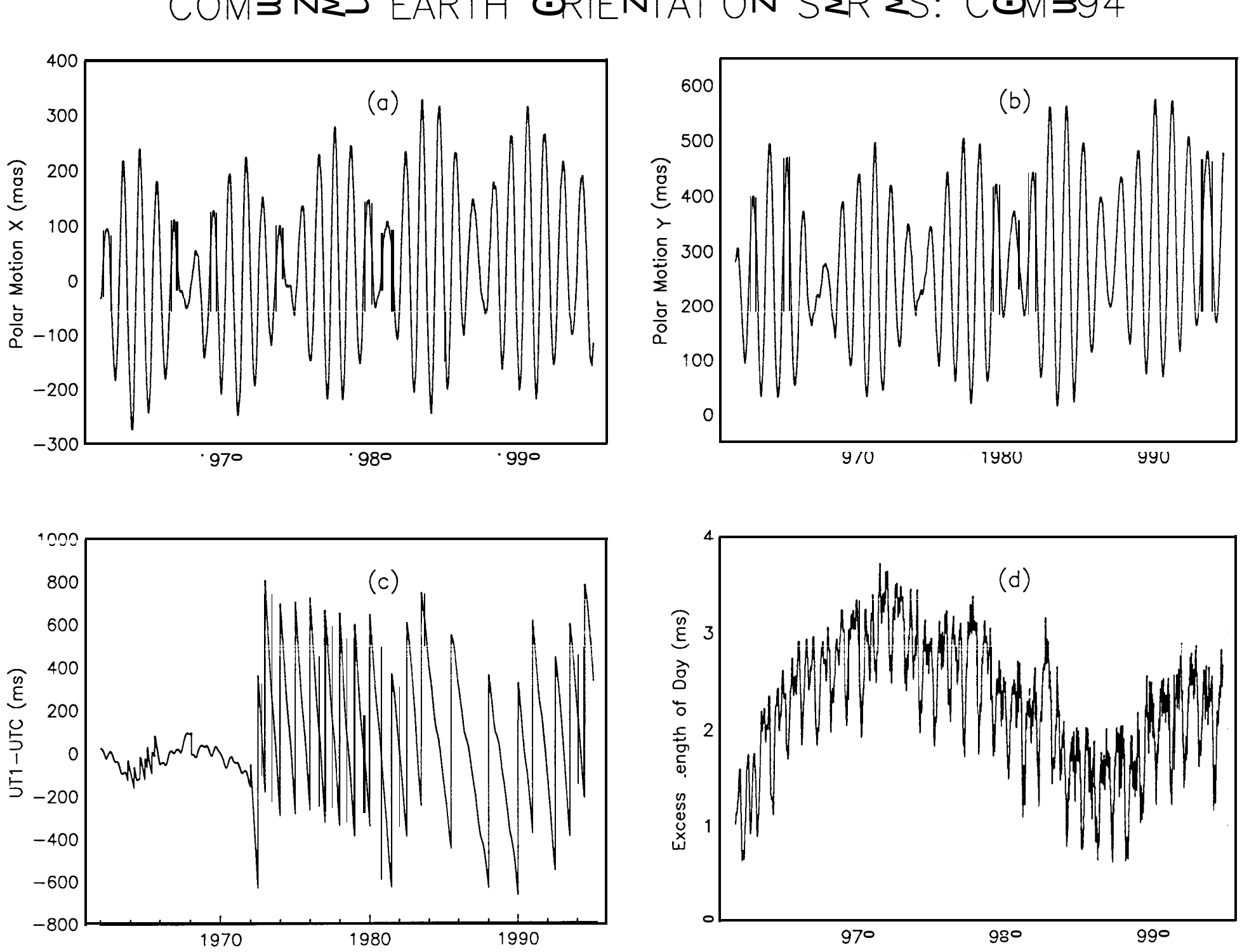
8 - Estimated Parameters:

a - Celestial Frame:

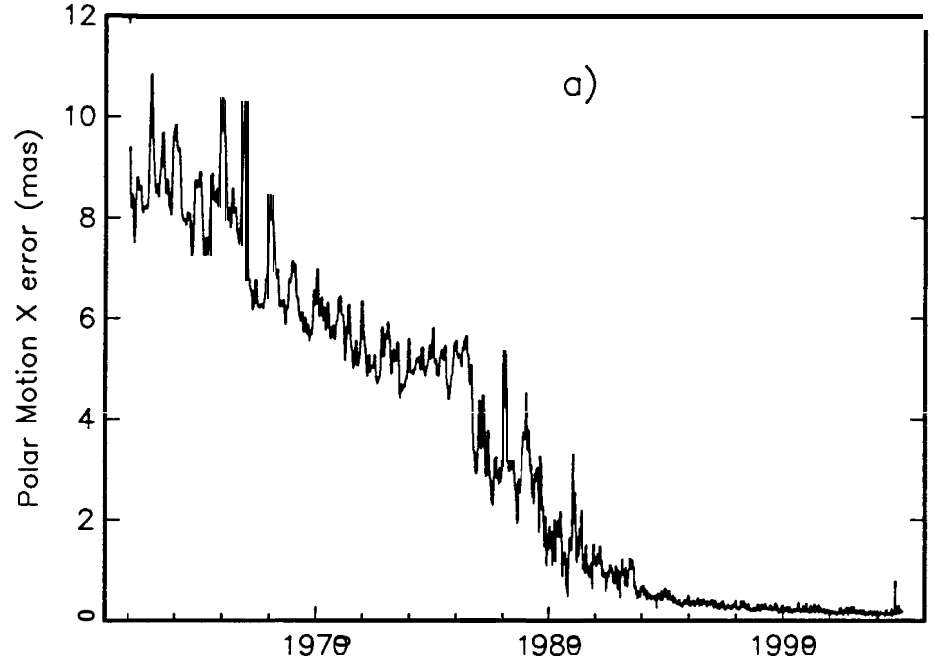
b - Terrestrial Frame:

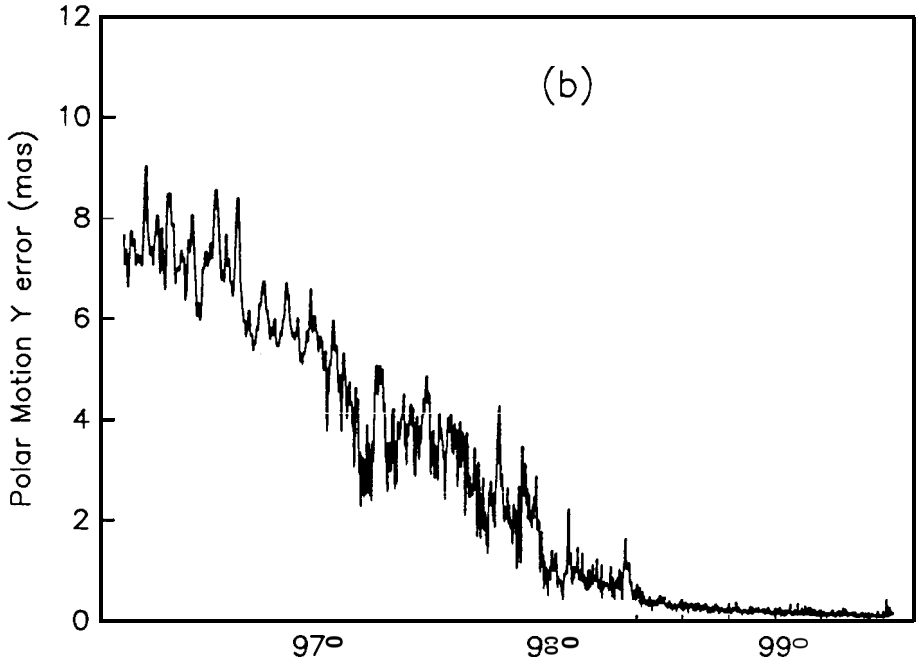
c – Earth Orientation: PMX, PMY

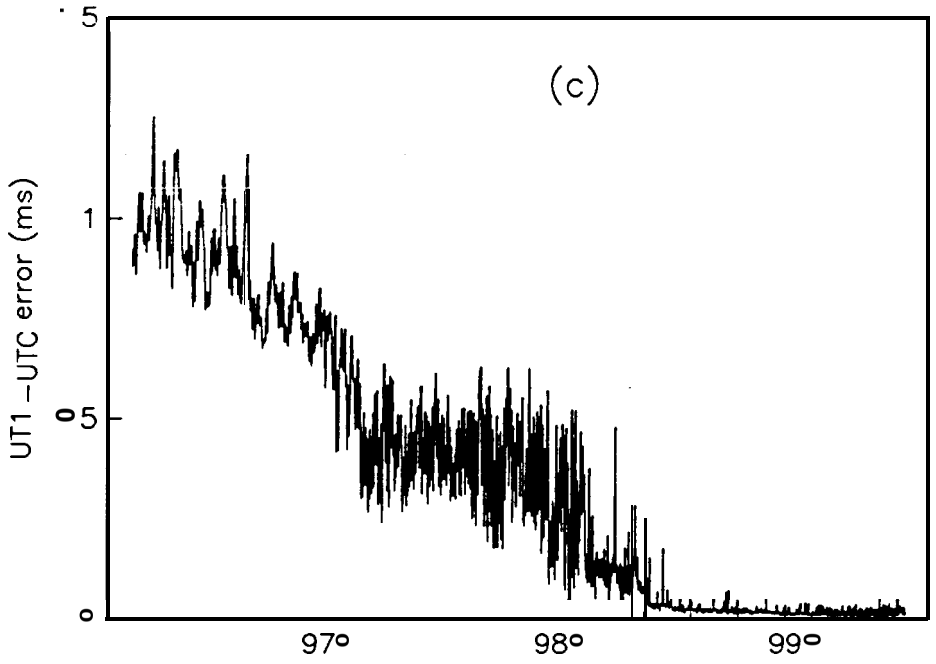
d - Others:

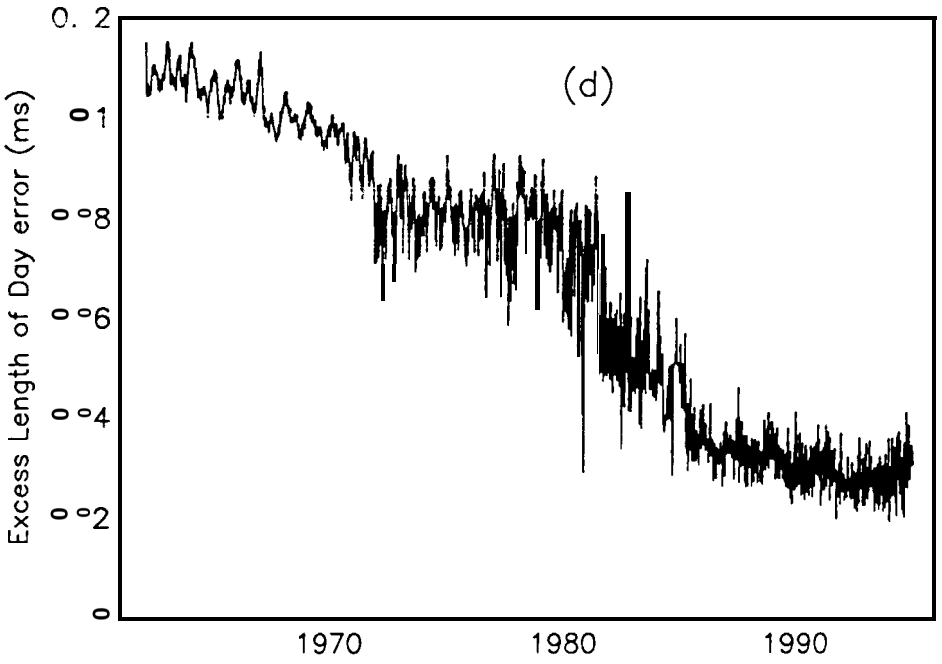

COMBINED EARTH ORIENTATION SERIES: COMB94
(a)
Polar Motion X (mas)
400
300
200
100
0
−100
−200
−300
·97°
·98°
·99°
(b)
Polar Motion Y (mas)
600
500
400
300
200
100
0
970
1980
990
(c)
UT1−UTC (ms)
1000
800
600
400
200
0
−200
−400
−600
−800
1970
1980
1990
(d)
Excess .ength of Day (ms)
4
3
2
1
0
97°
98°
99°

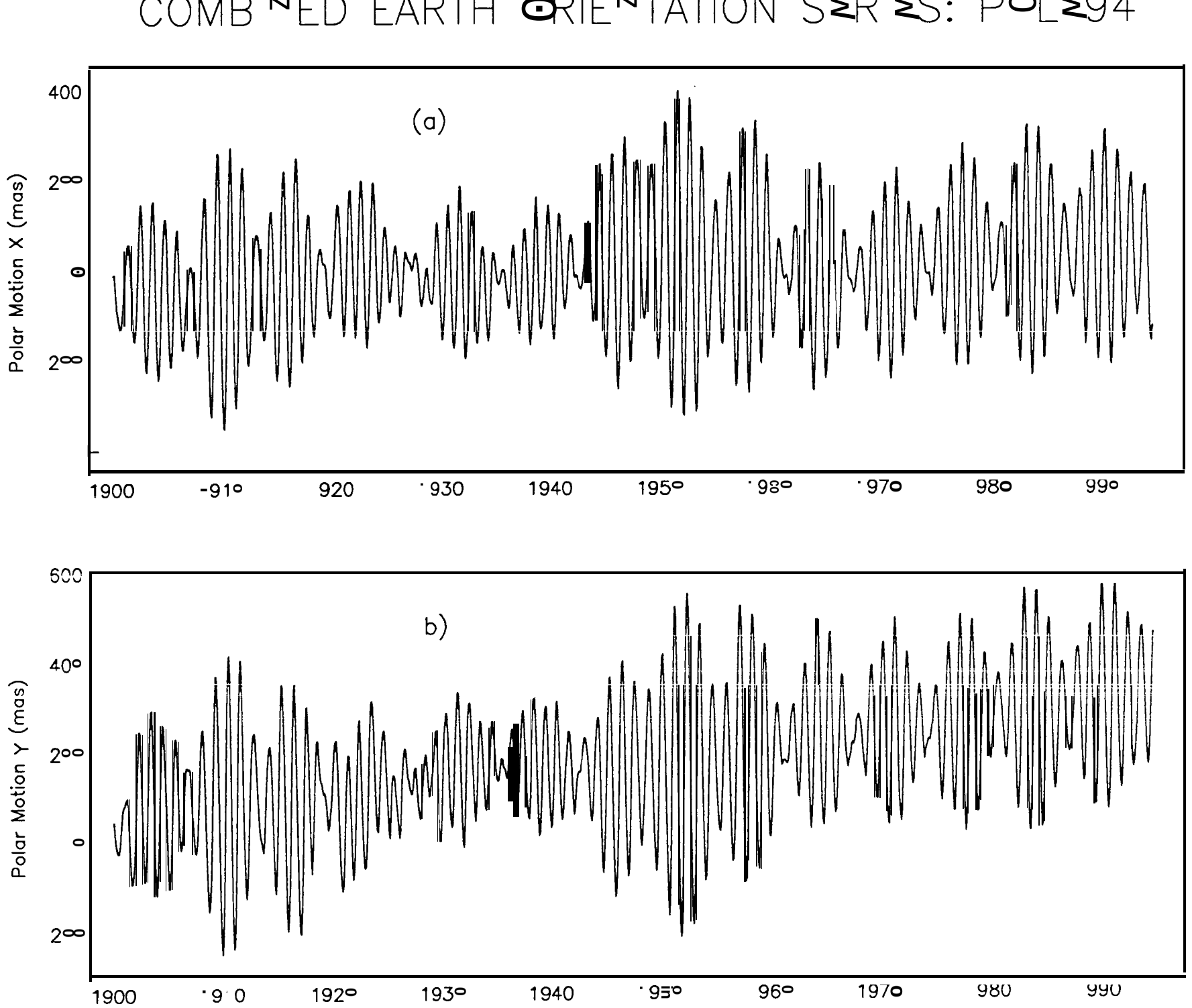
COMBINED EARTH ORIENTATION SERIES: COMB94










COMBINED EARTH ORIENTATION SERIES: POLE94
(a)
Polar Motion X (mas)
400
200
0
-200
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
(b)
Polar Motion Y (mas)
600
400
200
0
-200
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990

COMBINED EARTH ORIENTATION SERIES: POLE94